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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No. **MIO 0020 VA/97-0198.02**
First Inventor or Application Identifier **David R. Hembree**
Title **A Spring Element for use in an Apparatus for Attaching to a Semiconductor and a Method of Attaching**
Express Mail Label No. **EL524331677US**

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ☒ Specification [Total Pages **36**]
(preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets **9**]
4. Oath or Declaration [Total Pages **3**]
 - a. ☐ Newly executed (original or copy)
 - b. ☒ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 16 completed)
 - i. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

5. ☐ Microfiche Computer Program (Appendix)
6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
8. ☒ 37 C.F.R. § 3.73(b) Statement (when there is an assignee) ☒ Power of Attorney
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
11. ☒ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
13. ☐ * Small Entity Statement(s) ☐ Statement filed in prior application, Status still proper and desired (PTO/SB/09-12)
14. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
15. ☒ Other: Check \$1512.00 (filing fee)
Initial Information Data Sheet

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☒ Divisional ☐ Continuation-in-part (CIP) of prior application No: **09 / 026.080**
Prior application information: Examiner **R. Potter** Group / Art Unit: **2822**

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

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Name (Print/Type)	Timothy W. Hagan	Registration No. (Attorney/Agent)	29,001
Signature		Date	02/23/2000

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Initial Information Data Sheet

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Application Information

Title Line One:: A SPRING ELEMENT FOR USE IN AN APPARATUS
Title Line Two:: FOR ATTACHING TO A SEMICONDUCTOR AND A
Title Line Three:: METHOD OF ATTACHING
Total Drawing Sheets:: 9
Formal Drawings?: Yes
Application Type:: Utility
Docket Number:: MIO 0020 VA/97-0198.02

Representative Information

Registration Number One:: 26,397
Registration Number Two:: 27,262
Registration Number Three:: 29,001
Registration Number Four:: 39,564
Registration Number Five:: 38,769
Registration Number Six:: 44,339
Registration Number Seven:: 33,758
Registration Number Eight:: 42,695
Registration Number Nine:: 30,871
Registration Number Ten:: 34,095

Continuity Information

This application is a:: Division of
> Application One:: 09/026,080
Filing Date:: February 19, 1998

which is a:: Continuation in part of
> Application Two:: 09/009,169
Filing Date:: January 20, 1998

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	

Sir:

PRELIMINARY AMENDMENT

Please preliminarily amend the above-identified application as follows.

IN THE SPECIFICATION

Page 1, line 4 after "This application is a" insert --division of U.S. Patent Application Serial No. 09/026,080, filed February 19, 1998, which is a--.

IN THE CLAIMS

Please cancel claims 1-28 and 72.

REMARKS

Claims 29-71 and 73 were withdrawn from the continuation-in-part application as a result of a restriction requirement. Applicants respectfully request examination of those claims on the merits in this divisional application.

Respectfully submitted,
KILLWORTH, GOTTMAN, HAGAN
& SCHAEFF, L.L.P. /

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A SPRING ELEMENT FOR USE IN AN APPARATUS FOR ATTACHING
TO A SEMICONDUCTOR AND A METHOD OF ATTACHING

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation-in-Part of U.S. Patent Application Serial No.

5 09/009,169, filed January 20, 1998.

BACKGROUND OF THE INVENTION

The present invention relates in general to spring elements, and, more particularly, to a spring element for use in an apparatus for attaching to a plurality of contacts of a semiconductor.

10 Unpackaged or bare semiconductor dies are used to construct multi-chip modules (MCMs) and other electronic devices. Unpackaged dies must be tested and burned in during the manufacturing process to certify each die as a known good die. This has led to the development of temporary packages that hold a single bare die for testing and burn-in. The temporary packages provide the electrical interconnection
15 between the test pads on the die and external test circuitry. Exemplary temporary packages are disclosed in U.S. Patent Nos. 5,302,891, 5,408,190 and 5,495,179 to Wood et al., which are herein incorporated by reference.

Typically, this type of temporary package includes an interconnect having contact members that make a temporary electrical connection with the test pads on the
20 die. The temporary package can also include an attachment device that presses the die against the interconnect. The attachment device may include a clamping device that attaches to a package base and a spring element that presses the die against the interconnect. The configuration of the spring element is dependent on a number of factors. The spring element must be able to withstand relatively high compressive
25 forces and relatively high burn-in temperatures without experiencing compression set. Further, the dimensions of the spring element must be such that it is compatible with the temporary package. Finally, the spring element must be able to withstand the amount of pressure required for pressing the die against the interconnect without

causing an excessive amount of force to be transferred to the die, and thus damaging the same.

Springs elements used in the prior art are typically formed using rubber-like materials, such as silicone. Such springs elements are poor conductors of heat and electricity which limits the applications in which they can be used. It would be desirable to have a spring element which was electrically conductive for backside biasing of the semiconductor being tested. It would also be desirable to have a spring element which had improved thermal conduction properties for those applications in which increased heat dissipation is necessary.

Accordingly, there is a need for a spring element which is compatible with the temporary packages and environment used to test and burn-in semiconductors. There is also a need for a spring element which has improved thermal and electrical conduction properties. Preferably, such spring elements would be reusable and inexpensive to manufacture.

SUMMARY OF THE INVENTION

The present invention meets this need by providing a spring element having a modulus of elasticity which may be adjusted according to the required environment. Metallic particles or films may be added to the spring element to increase its thermal and electrical conduction properties. The spring element may be wrapped in a metallized woven fabric and mechanically clamped to the cover of the semiconductor testing device, thereby alleviating the need for a load distributing pressure plate. Material may be removed from or added to the spring element to change the modulus of elasticity as needed. The shape of the spring element may also be varied to change the modulus of elasticity, the spring constant, and the force transfer capabilities of the spring element.

According to a first aspect of the present invention, a spring element comprises a first elastic member and a conductive member. The first elastic member is comprised of a first elastomeric material having a first modulus of elasticity. A portion of the first

elastomeric material is removed from the first elastic member such that the spring element has an overall modulus of elasticity different from the first modulus of elasticity.

The portion of the first elastomeric material removed from the first elastic member may form a hole in the first elastic member. Preferably, the first elastic member is o-ring shaped. The first elastic member may also comprise a plurality of holes. The spring element may further comprise a second elastic member comprised of a second elastomeric material having a second modulus of elasticity, with the second elastic member being positioned in at least one of the plurality of holes formed in the first elastic member such that the overall modulus of elasticity is different from the first and second moduli of elasticity. The spring element may further comprise a plurality of the second elastic members with the plurality of the second elastic members being positioned in a plurality of the plurality of holes in the first elastic member. The portion of the first elastomeric material removed from the first elastic member may form a cavity in the first elastic member. Preferably, the first elastic member includes a plurality of cavities formed therein.

The conductive member may comprise a plurality of conductive particles. Preferably, the plurality of conductive particles are interspersed within the first elastic member. Alternatively, the conductive member may comprise a layer of conductive material formed over the first elastic member or a plurality of conductive threads. The plurality of conductive threads may comprise a plurality of non-conductive threads having a conductive coating. Preferably, the plurality of conductive threads form a covering around the first elastic member. The conductive member may be comprised of conductive material selected from the group consisting of gold, aluminum, nickel, silver stainless steel, and alloys thereof. The conductive member may also be comprised of carbon.

According to another aspect of the present invention, a spring element comprises a first elastic member, a second elastic member and a conductive member. The first elastic member is comprised of a first elastomeric material having a first modulus of elasticity and the second elastic member is comprised of a second

elastomeric material having a second modulus of elasticity. The second elastic member is positioned within the first elastic member such that the spring element has an overall modulus of elasticity different from the first and second moduli of elasticity.

The spring element may further comprise a plurality of the second elastic
5 members positioned within the first elastic member. The conductive member may comprise a plurality of conductive particles, a layer of conductive material formed over the first elastic member, or a plurality of conductive threads.

According to a further aspect of the present invention, a spring element
10 comprises a plurality of interwoven threads and a conductive member. The conductive member may comprise a plurality of conductive particles, a layer of conductive material formed over the first elastic member, or a plurality of conductive threads. Preferably, the plurality of conductive threads are interwoven with the plurality of interwoven threads.

According to yet another aspect of the present invention, a spring element
15 comprises a conductive member and an elastic member having a variable spring constant. The conductive member may comprise a plurality of conductive particles, a layer of conductive material formed over the first elastic member, or a plurality of conductive threads.

According to another aspect of the present invention, an apparatus for attaching
20 to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of
25 contacts. The attachment device comprises a spring element including an elastomeric member and a conductive member.

The conductive member may comprise a plurality of conductive particles. Preferably, the plurality of conductive particles are interspersed within the first elastic member. Alternatively, the conductive member may comprise a layer of conductive

material formed over the first elastic member or a plurality of conductive threads. The plurality of conductive threads may comprise a plurality of non-conductive threads having a conductive coating. Preferably, the plurality of conductive threads form a covering around the first elastic member. Preferably, the conductive member is
5 comprised of conductive material selected from the group consisting of gold, aluminum, nickel, silver, stainless steel, and alloys thereof. The conductive member may also be comprised of carbon.

The semiconductor may be electrically biased through the spring element. The semiconductor may comprise a semiconductor die. The semiconductor may comprise
10 a semiconductor die formed within a semiconductor package. The semiconductor package may comprise a package selected from the group consisting of a chip-scale package, a ball grid array, a chip-on-board, a direct chip attach, and a flip-chip.

According to yet another aspect of the present invention, an apparatus for
15 attaching to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of
20 contacts. The attachment device comprises a cover and a spring element mechanically coupled to the cover. The spring element comprises an elastomeric member and a plurality of conductive threads forming a covering over the spring element.

The cover may comprise a first clamping member configured so that a first end
25 portion of the spring element is force fit to the cover. The cover may further comprise a second clamping member configured so that a second end portion of the spring element is force fit to the cover.

According to a further aspect of the present invention, an apparatus for attaching
to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the



interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of contacts. The attachment device comprises a spring element including a conductive member and a first elastic member comprised of a first elastomeric material having a first modulus of elasticity. The first elastic member includes a plurality of holes formed therein such that the spring element has an overall modulus of elasticity different from the first modulus of elasticity.

According to a still further aspect of the present invention, an apparatus for attaching to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of contacts. The attachment device comprises a spring element including an elastic member comprised of a conductive member and an elastomeric material having a modulus of elasticity. The elastic member includes a hole formed therein such that the spring element has an overall modulus of elasticity different from the modulus of elasticity of the elastomeric material. The elastic member is shaped so as to engage an outer edge of the semiconductor such that a force applied by the attachment device as the interconnect structure is pressed against the semiconductor is substantially uniform around the semiconductor.

According to yet a still further aspect of the present invention, an apparatus for attaching to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of contacts. The attachment device comprises a spring element including a first elastic member, a second elastic member and a conductive member. The first elastic member

comprises a first elastomeric material having a first modulus of elasticity and the second elastic member comprises a second elastomeric material having a second modulus of elasticity. The second elastic member is positioned within the first elastic member such that the spring element has an overall modulus of elasticity different from the first and second moduli of elasticity.

According to another aspect of the present invention, an apparatus for attaching to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts on the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of contacts. The attachment device comprises a spring element comprised of a plurality of interwoven threads and a conductive member.

According to yet another aspect of the present invention, an apparatus for attaching to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection between the plurality of conductors and the corresponding ones of the plurality of contacts. The attachment device comprises a spring element including a conductive member and an elastic member comprised of an elastomeric material having a modulus of elasticity. The elastic member includes at least one cavity formed therein such that the spring element has an overall modulus of elasticity different from the modulus of elasticity of the elastomeric material.

According to a further aspect of the present invention, an apparatus for attaching to a plurality of contacts of a semiconductor comprises an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of the plurality of contacts of the semiconductor and an attachment device pressing the interconnect structure against the semiconductor to provide an electrical connection



between the plurality of conductors and the corresponding ones of the plurality of contacts. The attachment device comprises a spring element including a conductive member and an elastic member having a variable spring constant.

Accordingly, it is an object of the present invention to provide a spring element
5 which is compatible with the temporary packages and environment used to test and burn-in semiconductors. It is another object of the present invention to provide a spring element which has improved thermal and electrical conduction properties. It is another object of the present invention to provide a spring element which is reusable and inexpensive to manufacture. Other features and advantages of the invention will be
10 apparent from the following description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded view of a temporary package for testing semiconductors;

Fig. 2 is a cross-sectional view of the assembled temporary package shown in

15 Fig. 1;

Fig. 3 is a plan view of an interconnect structure for testing semiconductor dies used in the temporary package of Fig.1 according to first aspect of the present invention;

Fig. 4 is a schematic plan view of a semiconductor die to be tested in the
20 temporary package of Fig. 1 according to the first aspect of the present invention;

Fig. 5 is a schematic plan view of a semiconductor package to be tested in the temporary package of Fig. 1 according to a second aspect of the present invention;

Fig. 6 is a plan view of an interconnect structure for testing semiconductor packages used in the temporary package of Fig.1 according to the second aspect of the
25 present invention;

Fig. 7 is a perspective view of a spring element according to a first embodiment of the present invention;

Fig. 8 is perspective view of a spring element according to a second embodiment of the present invention;

Fig. 9 is perspective view of a spring element according to a third embodiment of the present invention;

5 Fig. 10 is perspective view of a spring element according to a fourth embodiment of the present invention;

Fig. 11 is perspective view of a spring element according to a fifth embodiment of the present invention;

10 Fig. 12 is perspective view of a spring element according to a sixth embodiment of the present invention;

Fig. 13 is a perspective view of a spring element according to a seventh embodiment of the present invention;

Figs. 14-18 are perspective views of the spring element of Fig. 13 according to various aspects of the present invention;

15 Fig. 19 is an exploded view of a temporary package for testing semiconductors using a spring element having a conductive material; and

Fig. 20 is a side view of the cover and spring element of Fig. 19 coupled together.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

20 Referring now to Figs. 1 and 2, a typical temporary package 10 used for testing a semiconductor 12 is shown. The temporary package 10 includes a package base 14, an interconnect structure 16, and an attachment device 18. The interconnect structure 16 establishes electrical communication between the package base 14 and the semiconductor 12. The attachment device 18 secures the semiconductor 12 to the
25 package base 14 and presses the semiconductor 12 against the interconnect structure 16. The attachment device 18 includes a pressure plate 20, a spring element 22, a cover 24 and a pair of clips 26, 28.



The interconnect structure 16 is positioned within a recess 30 formed within the package base 14. The semiconductor 12 is positioned over the interconnect structure 16 and held within another recess 32 formed within the package base 14. The spring element 22 is secured to the cover 24 using an appropriate adhesive. However, it will be appreciated by those skilled in the art that the spring element 22 may be used without being secured to the cover 24. The pressure plate 20 overlies the semiconductor 12 and is pressed against the semiconductor 12 by the spring element 22 and the cover 24. Accordingly, the semiconductor 12 is pressed against the interconnect structure 16 thereby establishing an electrical connection between the semiconductor 12, the interconnect structure 16 and the package base 14.

The cover 24 is secured to package base 14 by the clips 26 and 28. The clips 26, 28 engage a top portion of the cover 24 and are secured to the package base 14 through corresponding openings 34, 36 in the base 14. It will be appreciated by those skilled in the art that other types of latching mechanisms may be used to secure the cover 24 to the package base 14. The cover 24, the spring element 22, the pressure plate 20 and the package base 14 each include a central opening which are designated 24A, 22A, 20A and 14A, respectively. The openings 24A, 22A, 20A and 14A are used during assembly of the package 10 to permit the semiconductor 12 to be held by a vacuum tool (not shown) during optical alignment of the semiconductor 12 and the interconnect structure 16. The vacuum tool may also be used to disassemble the package 10 as required.

The apparatus 10 may be used to test semiconductors 12 in a variety of forms. According to a first aspect of the present invention, the apparatus 10 is used to test bare semiconductor dies 12', see Fig. 4. The interconnect structure 16 is arranged so as to interface with such semiconductor dies 12'. Referring to Fig. 3, the interconnect structure 16 includes a plurality of conductors 38. Each of the plurality of conductors 38 includes a contact member 40, a connection line 42 and a bonding site 44. The contact members 40 are formed in a pattern which correspond to a plurality of contacts or bond pads 46 on the semiconductor die 12'; see also Fig. 4. The contact members 40 are

adapted to contact and establish an electrical connection with the bond pads 46 on the semiconductor die 12'. For example, the contact members 40 may include a raised portion (not shown) which contacts the bond pads 46 as the semiconductor die 12' is pressed against the interconnect structure 16. The connection lines 42 terminate at the bonding sites 44 for connection to the package base 14. The bonding sites are connected to respective conductive traces 48 on the package base 14 using bond wires 50. The interconnect structure 16 may include a number of test structures (not shown) for evaluating various electrical characteristics of the interconnect structure 16. Once assembled, the semiconductor die 12' may be tested and burned-in as desired.

In the illustrated embodiment, the interconnect 16 is formed of a silicon substrate using conventional semiconductor technology. Similarly, the plurality of conductors 38 are formed of an appropriate conductive material using conventional semiconductor technology. The interconnect structure 16 may be formed according to U.S. Patent Nos. 5,326,428; 5,419,807 and 5,483,741 which are herein incorporated by reference. In the illustrated embodiment, the semiconductor die 12' is formed of a silicon substrate with a number of additional semiconductor layers forming the desired semiconductor device using conventional semiconductor technology. It will be appreciated by those skilled in the art that the semiconductor die 12' may be formed of other semiconductor materials, such as gallium arsenide.

According to a second aspect of the present invention, the apparatus 10 is used to test semiconductor packages 12"; see Fig. 5. The semiconductor package 12" includes at least one semiconductor die 12' and an additional structure 52. The structure 52 basically reroutes the bond pads 46 from the edge of the semiconductor die 12' towards the center of the semiconductor die 12'. This rerouting reduces the precision required for aligning the bond pads 46 with the contact members 40 as there is a greater area in which to position the bond pads 46. The structure 52 includes a plurality of conductive traces 54 electrically coupled to respective bond pads 46. The traces 54 are routed toward the center of the semiconductor die 12' in any desired pattern. The end of each trace 54 includes bonding member 56, such a solder ball.



The bonding member 56 is typically larger than the corresponding bond pad 46 such that the precision in aligning the contact members 40 with the bonding member 56 is reduced. The semiconductor package 12" may comprise a chip-scale package (CSP), ball grid array (BGA), chip-on-board (COB), direct chip attach (DCA), flip-chips and other similar packages. As shown in Fig. 6, the interface structure 16 is arranged and configured to interface with the semiconductor package 12" as is known in the art. It should be apparent from the above description that the semiconductor 12 may comprise bare semiconductor dies and semiconductor dies arranged in packages as is known in the art.

The spring element 22 is composed of an elastomeric material. In the illustrated embodiment, the elastomeric material comprises silicone as it is compatible with the high temperatures associated with burn-in. However, silicone and the silicon used to form the semiconductor 12 tend to bond together due to molecular surface attraction and the compressive forces encountered as the semiconductor 12 is pressed against the interconnect structure 16. Such a bond could damage the underlying structures of the semiconductor 12 as well as the semiconductor 12 itself as the semiconductor 12 and the spring element 22 are separated. The pressure plate 20 acts as an interface between the semiconductor 12 and the spring element 22 to prevent such a bond from forming. The pressure plate 20 is thus composed of a suitable material which is compatible with the spring element 22 and the semiconductor 12 so as to prevent a bond from forming between any of the aforementioned structures. It will be appreciated by those skilled in the art that spring element 22 may be composed of other elastomeric materials, such as appropriate urethanes and polyesters. Further, the pressure plate 20 may be omitted if the material used to form the spring element 22 does not bond to the semiconductor 12 when subjected to high pressure and temperature. The pressure plate also distributes the force from the spring element 22 in a uniform manner.

Typically, the semiconductor 12 and the temporary package are relatively small thereby limiting the area or thickness of the spring element 22. The thickness of the spring element 22 may range between approximately 15 mils (0.381 mm) to

approximately 125 mils (3.177 mm). However, it will be appreciated by those skilled in the art that the spring element 22 may be any desired thickness depending on the particular package 10 and semiconductor 12. The spring element 22 absorbs some of the force or pressure applied to it as it is compressed by the cover 24. The spring
5 element 22 is sized and configured to transfer a desired amount of pressure to the semiconductor 12. A sufficient amount of pressure needs be applied to the semiconductor 12 so that it properly engages the interconnect structure 16. However, an excessive amount of pressure could damage the semiconductor 12 and the interconnect structure 16. As the dimensions of the spring element 22 are limited due
10 to the size of the semiconductor 12 and the package 10, the configuration of the spring element 22 may be changed so that it exhibits the desired pressure absorption and force transfer characteristics.

The force applied by the spring element 22 may be changed by changing the area of the spring element 22 to be compressed. For example, a pressure plate 20
15 which is larger than the outer dimensions of the semiconductor 12 may be used with a lower psi spring element 22. The larger pressure plate 20 limits the overall compression height of the spring element 22 while applying the appropriate amount of force. Reducing the amount that the spring element 22 is compressed lessens the compression set of the spring element 2.

20 One feature of the spring element 22 which may be changed is its modulus of elasticity. Lowering the modulus of elasticity of the spring element 22 would enable it to absorb more force or pressure so that the amount of pressure applied to the semiconductor 12 is within acceptable levels. Another way of describing such function is forming low psi (lbs. per square inch) materials from high psi materials. Conversely,
25 the modulus of elasticity may be increased so as to lessen the amount of force or pressure absorbed by the spring element 22 and thus increase the amount of force or pressure applied to the semiconductor 12 for a given deflection amount.

Referring now to Fig. 7, the spring element 22 according to a first embodiment of the present invention is shown. The spring element 22 comprises a first elastic

member 100 comprised of a first elastomeric material having a first modulus of elasticity. In the illustrated embodiment, the first elastomeric material comprises silicone. The silicone may be substantially solid or foam-like by having gas bubbles blown through it during fabrication using conventional methods. It should be apparent
5 that the first modulus of elasticity is dependent, in part, on the configuration of the silicone as being foam-like or substantially solid. Foam-like material is more easily compressed than substantially solid material as the gas bubbles in the foam-like material are more easily compressible. A plurality of openings 102 are formed in the first elastic member 100 in addition to the opening 22A described above. The plurality
10 of openings 102 may extend partially or completely through the first elastic member 100. The plurality of openings 102 are formed by wet drilling the first elastic member 100. Wet drilling is particularly advantageous as it will not leave residual oil or particles from the silicone on the first elastic member 100. The plurality of openings 102 may also be formed using other appropriate methods, such as by molding, regular drilling,
15 laser drilling or by punching out the desired openings. An overall modulus of elasticity of the spring element 22 is thus dependent on the size and total number of openings 102 through the first elastic member 100. The overall modulus of elasticity of the spring element 22 is lower than the first modulus of elasticity of the first elastic member 100 in direct relation to the quantity of first elastomeric material removed from the first elastic
20 member 100. The spring element 22 is thus more compressible.

The overall modulus of elasticity of the spring element 22 may be further changed by adding one or more second elastic members 104 to the first elastic member 100. The second elastic members 104 are comprised of a second elastomeric material having a second modulus of elasticity different from the first modulus of
25 elasticity. The second elastic members 104 may be positioned in one or more of the openings 102 as desired. In the illustrated embodiment, the second elastic members 104 also comprise silicone which may be substantially solid or foam-like. The overall modulus of elasticity of the spring element 22 with the second elastic members 104 in the openings 102 will be at least greater than the overall modulus of elasticity of the

spring element 22 with empty openings 102. Further, the overall modulus of elasticity of the spring element 22 may be greater than the first modulus of elasticity if the second elastomeric material is stiffer or more dense than the first elastomeric material.

Referring now to Fig. 8, the spring element 22 according to a second embodiment of the present invention is shown, with like reference numerals corresponding to like elements. In this embodiment, one or more of the second elastic members 104 are positioned within the first elastic member 100. The second elastic members 104 are formed with the first elastic member 100 as the first elastic member 100 is fabricated. As with the first embodiment, the overall modulus of elasticity is dependent on the number and size of the second elastic members 104. The second elastic members 104 may have any desired shape. In the illustrated embodiment, the second elastic members 104 are generally spherical or oblong. The second elastic members 104 may be foam-like or substantially solid depending on the desired properties of the spring element 22.

Referring now to Fig. 9, the spring element 22 according to a third embodiment of the present invention is shown. The spring element 22 comprises an elastic member 106 comprised of an elastomeric material having a modulus of elasticity. The elastic member 106 is shaped so that it engages an outer edge of the semiconductor 12 as it presses the semiconductor 12 against the interconnect structure 16. The spring element 22 of this embodiment includes a relatively large hole 108 through the elastomeric material such that the overall modulus of elasticity of the spring element 22 is different from the modulus of elasticity of the elastic member 106. As the spring element 22 engages the outer edge of the semiconductor 12, the force or pressure from the compressed spring element 22 is substantially uniform around the semiconductor 12. By engaging only the outer edge of the semiconductor 12, the applied force or pressure from the spring element 22 is substantially uniform compared to a sheet in which more force or pressure is applied to the center than the edges due to the deflection properties of a sheet versus an o-ring. In the illustrated embodiment, the elastic member 106 is o-ring shaped.



Referring now to Fig. 10, the spring element 22 according to a fourth embodiment of the present invention is shown. The spring element 22 comprises a plurality of interwoven threads 110. The amount in which the spring element of the fourth embodiment may be compressed is dependent, in part, to the size and the degree in which the threads 110 are woven together. The threads 110 are comprised of an elastomeric material which is silicone in the illustrated embodiment.

Referring now to Fig. 11, the spring element 22 according to a fifth embodiment of the present invention is shown. The spring element 22 comprises an elastic member 112 comprised of an elastomeric material having a modulus of elasticity. One or more cavities or dimples 114 are formed in the elastic member 112. The overall modulus of elasticity of the spring element 22 is thus dependent on the size and number of cavities 114. The cavities 114 may be formed by molding them into the elastic member 112 or by cutting cavities out of the elastic member 112. The cavities 114 may comprise any desired shape.

Referring now to Fig. 12, the spring element 22 according to a sixth embodiment of the present invention is shown. The spring element 22 comprises an elastic member 116 having a variable spring constant. The elastic member 116 has a repeating diamond shaped cross-section with a set of first peaks 116A and a set of second peaks 116B. The spring constant of the elastic member 116 changes based on the level of compression. The spring constant increases in direct proportion to the level of compression. The spring constant increases with compression because a greater amount of material is compressed. As there is less material near the peaks 116A, 116B, the amount of material compressed is less such that the spring constant is low. However, as compression increases, the amount of material compressed also increases such that the spring constant is higher. The elastic member 116 may have different shapes provided that the spring constant changes with the degree of compression. The elastic member 116 may have a triangular cross-section or a repeating triangular shaped cross-section. The elastic member 116 may be formed by

molding or extruding an appropriate elastomeric material. The elastomeric material may be substantially solid or foam-like.

Referring now to Fig. 13, a spring element 22 according to a seventh embodiment of the present invention is illustrated. The spring element 22 comprises an elastomeric material 118 having any of the above configurations and a conductive member 120. The conductive member 120 is configured so as to make the spring element 22 electrically conductive and/or to improve its thermal conductivity. An electrically conductive spring element 22 enables the semiconductor 12 to be backside biased through the spring element 22 as required for the particular test being performed. A spring element with improved thermal conductivity may be used in an application where heat dissipation is required.

As shown in Fig. 13, the conductive member 120 may take the form of a plurality of conductive particles 122 interspersed within the spring element 22. The concentration of conductive particles 122 is chosen so as to optimize the desired electrical and thermal conduction properties without adversely affecting the elasticity of the spring element 22. The conductive particles 122 may be mixed with the elastomeric material 118 as the spring element 22 is being formed. Another method of adding the conductive particles 122 to the spring element 22 is to inject them into the elastomeric material 118 after the spring element 22 is formed using known methods.

As shown in Fig. 14, the conductive particles 122 may also be applied to one or more surfaces of the spring element 22 using an appropriate adhesive. The concentration of the conductive particles 122 may be such that a layer of conductive material is formed on one or more surfaces of the spring element 22. In the alternative, a coating of conductive material 124 may be formed over one or more surfaces of the spring element 22 to form a layer of conductive material as shown in Fig. 15. Conductive material, in liquid form, may be applied to one or more surfaces of the spring element 22, as desired, using methods known in the art. The conductive material may also be applied by sputtering.

Referring now to Figs. 16-18, the conductive member 120 may comprise a plurality of conductive threads 126. The conductive threads 126 may be set within the elastomeric material 118 as the spring element 22 is formed or the conductive threads 126 may be applied to one or more surfaces of the spring element 22 using an appropriate adhesive as shown in Fig. 16. Alternatively, the conductive threads 126 may be interwoven so as to form a fabric 128 of conductive material which is wrapped around the elastomeric material 118 as shown in Fig. 17. The fabric 128 may be arranged so as to encase or cover the elastomeric material 118. Such a covering adds structural strength and protects the spring element 22 as well as being electrically and/or thermally conductive.

Referring now to Fig. 18, the spring element 22 may comprise the plurality of interwoven threads 110 and the plurality of conductive threads 126 interwoven together. The ratio between threads 110 and conductive threads 126 may be adjusted so that the spring element 22 exhibits the desired elastic, electric and/or thermal properties. The conductive threads 126 may be formed of generally solid filaments of conductive material. Alternatively, the conductive threads 126 may be formed from filaments of non-conductive materials which are coated with conductive material.

The conductive material forming the conductive member 120 may be any desired electrically or thermally conductive material appropriate for the particular application. The conductive material may be comprised of any appropriate metal, such as gold, aluminum, nickel, silver, stainless steel, and alloys thereof. The conductive material may also be comprised of carbon in diamond or graphite crystalline form. Diamond is particularly advantageous as it has very high thermal conductivity while graphite is electrically conductive.

Referring now to Fig. 19, another temporary package 10' used for testing a semiconductor 12 is shown, with like reference numerals corresponding to like elements. The spring element 22 is covered with the fabric 128 of conductive material. As the fabric 128 increases the strength and structural integrity of the spring element 22, the force applied by the cover 24 to the spring element 22 is better distributed to the



semiconductor 12. Accordingly, the pressure plate is not needed as its function is performed by the spring element 22 through the fabric 128. However, the pressure plate may still be used as desired.

Further, the added strength provided by the fabric 128 allows the spring element 22 to be mechanically coupled to the cover 24 as shown in Fig. 20. The cover 24 includes a first clamp 24B and a second clamp 24C for latching or clamping the spring element 22 to the cover 24. A first end portion 22A of the spring element 22 is compressed and clamped to the cover 24 by the first clamp 24B while a second end portion 22B of the spring element 22 is compressed and clamped to the cover 24 by the second clamp 24C. It will be appreciated by those skilled in the art that all of the end portions of the spring element 22 may be clamped to the cover 24.

In the illustrated embodiment, the spring element 22 is force fit to the cover 24 as the first and second clamps 24B and 24C comprise static latching shelves with the first and second end portions 22A and 22B being slid in place between the first and second clamps 24B and 24C. The spring element 22 may be easily removed from the cover 24 by applying sufficient force to overcome the force being applied by the clamps 24B and 24C. A new spring element 22 may then be slid and latched in place. Such a clamping device is cleaner and easier to use than adhesives. However, the spring element 22 may be adhered to the cover 24 as desired. It will be appreciated by those skilled in the art that other mechanical latching devices may be used to clamp the spring element 22 to the cover 24.

It will be appreciated by those skilled in the art that the spring element 22 may have any combination of the above embodiments. The final configuration of the spring element 22 will be dependent on the desired physical properties of the spring element 22 as well as the dimensional limitations for each particular package 10 and semiconductor 12. It will be further appreciated by those skilled in the art that the spring element 22 may be used with other temporary packages used to test semiconductors.



Having described the invention in detail and by reference to preferred embodiments thereof, it will be apparent that modifications and variations are possible without departing from the scope of the invention defined in the appended claims.



CLAIMS

What is claimed is:

1. A spring element comprising a first elastic member and a conductive member, said first elastic member being comprised of a first elastomeric material having a first modulus of elasticity, said first elastic member having a portion of said first elastomeric material removed such that said spring element has an overall modulus of elasticity different from said first modulus of elasticity.
2. The spring element of claim 1, wherein said portion of said elastomeric material removed from said first elastic member forms a hole in said first elastic member.
3. The spring element of claim 2, wherein said first elastic member is o-ring shaped.
4. The spring element of claim 2, wherein said first elastic member has a plurality of holes formed therein.
5. The spring element of claim 4, further comprising a second elastic member comprised of a second elastomeric material having a second modulus of elasticity, said second elastic member positioned in at least one of said plurality of holes formed in said first elastic member such that said overall modulus of elasticity is different from said first and second moduli of elasticity.
6. The spring element of claim 5, further comprising a plurality of said second elastic members, said plurality of said second elastic members positioned in a plurality of said plurality of holes in said first elastic member.



7. The spring element of claim 1, wherein said portion of said first elastomeric material removed from said first elastic member forms at least one cavity in the first elastic member.
8. The spring element of claim 7, wherein said first elastic member has a plurality of cavities formed therein.
9. The spring element of claim 1, wherein said conductive member comprises a plurality of conductive particles.
10. The spring element of claim 9, wherein said plurality of conductive particles are interspersed within said first elastic member.
11. The spring element of claim 1, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.
12. The spring element of claim 1, wherein said conductive member comprises a plurality of conductive threads.
13. The spring element of claim 12, wherein said plurality of conductive threads comprise a plurality of non-conductive threads having a conductive coating.
14. The spring element of claim 12, wherein said plurality of conductive threads form a covering around said first elastic member.
15. The spring element of claim 1, wherein said conductive member is comprised of conductive material selected from the group consisting of gold, aluminum, nickel, silver, stainless steel, and alloys thereof.



16. A spring element comprising a first elastic member, a second elastic member and a conductive member, said first elastic member being comprised of a first elastomeric material having a first modulus of elasticity, said second elastic member being comprised of a second elastomeric material having a second modulus of elasticity, said second elastic member positioned within said first elastic member such that said spring element has an overall modulus of elasticity different from said first and second moduli of elasticity.

17. The spring element of claim 16, further comprising a plurality of said second elastic members positioned within said first elastic member.

18. The spring element of claim 16, wherein said conductive member comprises a plurality of conductive particles.

19. The spring element of claim 16, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

20. The spring element of claim 16, wherein said conductive member comprises a plurality of conductive threads.



21. A spring element comprising a plurality of interwoven threads and a conductive member.

22. The spring element of claim 21, wherein said conductive member comprises a plurality of conductive particles.

23. The spring element of claim 21, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

24. The spring element of claim 21, wherein said conductive member comprises a plurality of conductive threads interwoven with said plurality of interwoven threads.



25. A spring element comprising a conductive member and an elastic member having a variable spring constant.
26. The spring element of claim 25, wherein said conductive member comprises a plurality of conductive particles.
27. The spring element of claim 25, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.
28. The spring element of claim 25, wherein said conductive member comprises a plurality of conductive threads.



29. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element including an elastomeric member and a conductive member.

30. The apparatus of claim 29, wherein said conductive member comprises a plurality of conductive particles.

31. The apparatus of claim 29, wherein said plurality of conductive particles are interspersed within said first elastic member.

32. The apparatus of claim 29, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

33. The apparatus of claim 29, wherein said conductive member comprises a plurality of conductive threads.

34. The apparatus of claim 33, wherein said plurality of conductive threads comprise a plurality of non-conductive threads having a conductive coating.

35. The apparatus of claim 33, wherein said plurality of conductive threads form a covering around said first elastic member.

36. The apparatus of claim 29, wherein said conductive member is comprised of conductive material selected from the group consisting of gold, aluminum, nickel, silver stainless steel, and alloys thereof.

37. The apparatus of claim 29, wherein said semiconductor is electrically biased through said spring element.

38. The apparatus of claim 29, wherein said semiconductor comprises a semiconductor die.

39. The apparatus of claim 29, wherein said semiconductor comprises a semiconductor die formed within a semiconductor package.

40. The apparatus of claim 39, wherein said semiconductor package comprises a package selected from the group consisting of a chip-scale package, a ball grid array, a chip-on-board, a direct chip attach, and a flip-chip.



41. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a cover and a spring element mechanically coupled to said cover, said spring element comprising an elastomeric member and a plurality of conductive threads forming a covering over said spring element.

42. The apparatus of claim 41, wherein said cover includes a first clamping member configured so that a first end portion of said spring element is force fit within said first clamping member.

43. The apparatus of claim 42, wherein said cover further includes a second clamping member configured so that a second end portion of said spring element is force fit within said second clamping member.



an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element including a conductive member and a first elastic member comprised of a first elastomeric material having a first modulus of elasticity, said first elastic member having a plurality of holes formed therein such that said spring element has an overall modulus of elasticity different from said first modulus of elasticity.

45. The apparatus of claim 44, wherein said spring element further comprises an elastic member comprised of a second elastomeric material having a second modulus of elasticity, said second elastic member positioned in at least one of said plurality of holes formed in said first elastic member such that said overall modulus of elasticity is different from said first and second moduli of elasticity.

46. The apparatus of claim 44, wherein said spring element further comprises a plurality of second elastic members positioned in a plurality of said plurality of holes in said first elastic member.

47. The apparatus of claim 44, wherein said conductive member comprises a plurality of conductive particles.

48. The apparatus of claim 44, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

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49. The apparatus of claim 44, wherein said conductive member comprises a plurality of conductive threads.



50. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element including an elastic member comprised of a conductive member and an elastomeric material having a modulus of elasticity, said elastic member having a hole formed therein such that said spring element has an overall modulus of elasticity different from said modulus of elasticity of said elastomeric material, said elastic member being shaped so as to engage an outer edge of said semiconductor such that a force applied by said attachment device as said interconnect structure is pressed against said semiconductor is substantially uniform around said semiconductor.

51. The apparatus of claim 50, wherein said conductive member comprises a plurality of conductive particles.

52. The apparatus of claim 50, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

53. The apparatus of claim 50, wherein said conductive member comprises a plurality of conductive threads.



54. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element including a first conductive member, a first elastic member and a second elastic member, a first elastomeric material having a first modulus of elasticity and said second elastic member comprising a second elastomeric material having a second modulus of elasticity, said second elastic member being positioned within said first elastic member such that said spring element has an overall modulus of elasticity different from said first and second moduli of elasticity.

55. The apparatus of claim 54, further comprising a plurality of said second elastic members formed within said first elastic member.

56. The apparatus of claim 54, wherein said conductive member comprises a plurality of conductive particles.

57. The apparatus of claim 54, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

58. The apparatus of claim 54, wherein said conductive member comprises a plurality of conductive threads.



59. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts on said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element comprised of a plurality of interwoven threads and a conductive member.

60. The apparatus of claim 59, wherein said conductive member comprises a plurality of conductive particles.

61. The apparatus of claim 59, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

62. The apparatus of claim 59, wherein said conductive member comprises a plurality of conductive threads interwoven with said plurality of interwoven threads.



63. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element including a conductive member and an elastic member comprised of an elastomeric material having a modulus of elasticity, said elastic member having at least one cavity formed therein such that said spring element has an overall modulus of elasticity different from said modulus of elasticity of said elastomeric material.

64. The apparatus of claim 63, wherein said elastic member has a plurality of cavities formed therein.

65. The apparatus of claim 63, wherein said conductive member comprises a plurality of conductive particles.

66. The apparatus of claim 63, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

67. The apparatus of claim 63, wherein said conductive member comprises a plurality of conductive threads.



68. An apparatus for attaching to a plurality of contacts of a semiconductor, said apparatus comprising:

an interconnect structure comprising a plurality of conductors patterned to match corresponding ones of said plurality of contacts of said semiconductor; and

an attachment device pressing said interconnect structure against said semiconductor to provide an electrical connection between said plurality of conductors and said corresponding ones of said plurality of contacts, said attachment device comprising a spring element including a conductive member and an elastic member having a variable spring constant.

69. The apparatus of claim 68, wherein said conductive member comprises a plurality of conductive particles.

70. The apparatus of claim 68, wherein said conductive member comprises a layer of conductive material formed over said first elastic member.

71. The apparatus of claim 68, wherein said conductive member comprises a plurality of conductive threads.

72. The spring element of claim 1, wherein said conductive member comprises carbon.

73. The apparatus of claim 29, wherein said conductive member comprises carbon.



ABSTRACT OF THE DISCLOSURE

A spring element used in a temporary package for testing semiconductors is provided. The spring element is compressed so as to press the semiconductor, either in the form of a bare semiconductor die or as part of a package, against an interconnect structure. The spring element is configured so that it provides sufficient pressure to keep the contacts on the semiconductor in electrical contact with the interconnect structure. Material is added and/or removed from the spring element so that it has the desired modulus of elasticity. The shape of the spring element may also be varied to change the modulus of elasticity, the spring constant, and the force transfer capabilities of the spring element. The spring element also includes conductive material to increase the thermal and electrical conductivity of the spring element.

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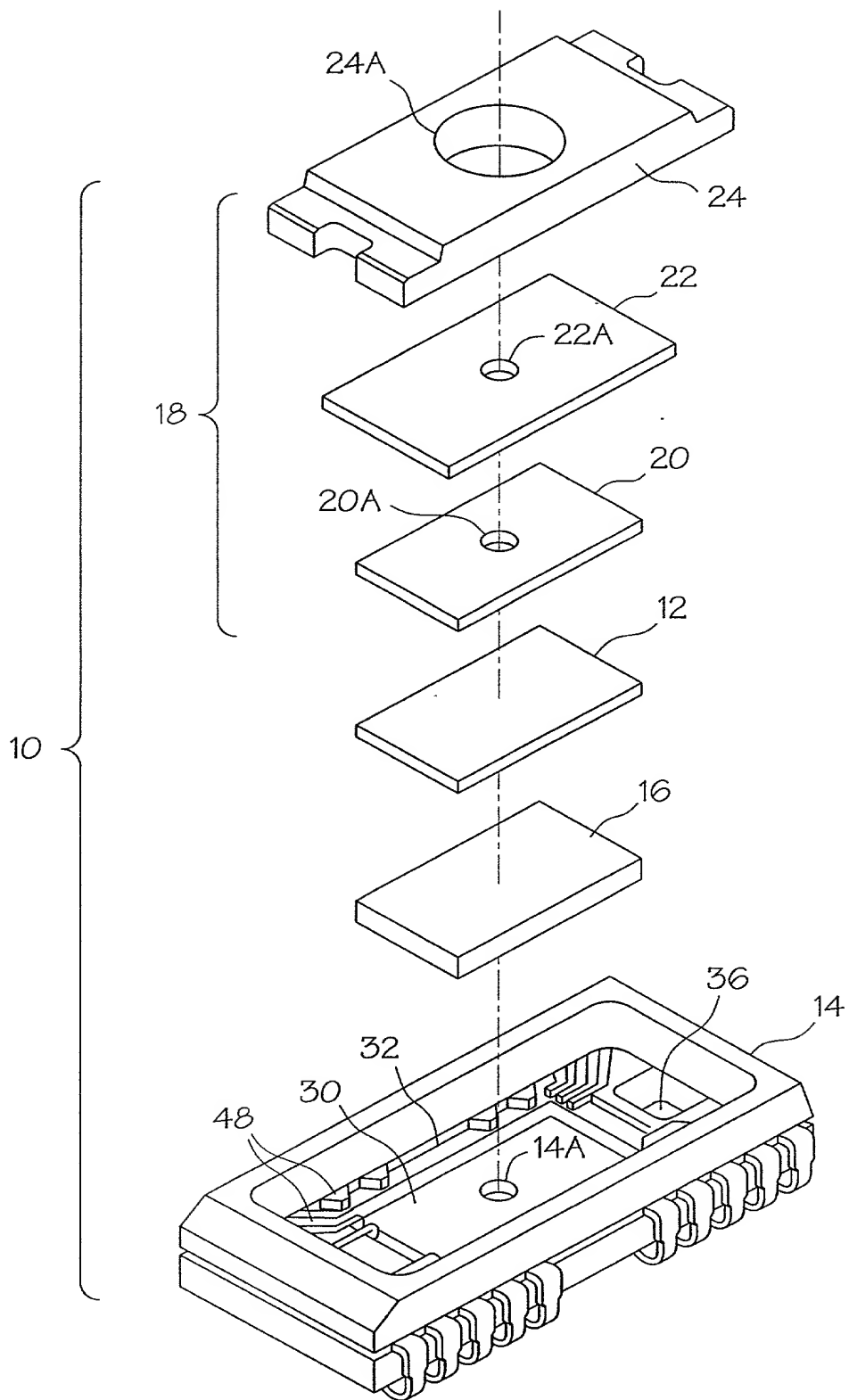


FIG. 1

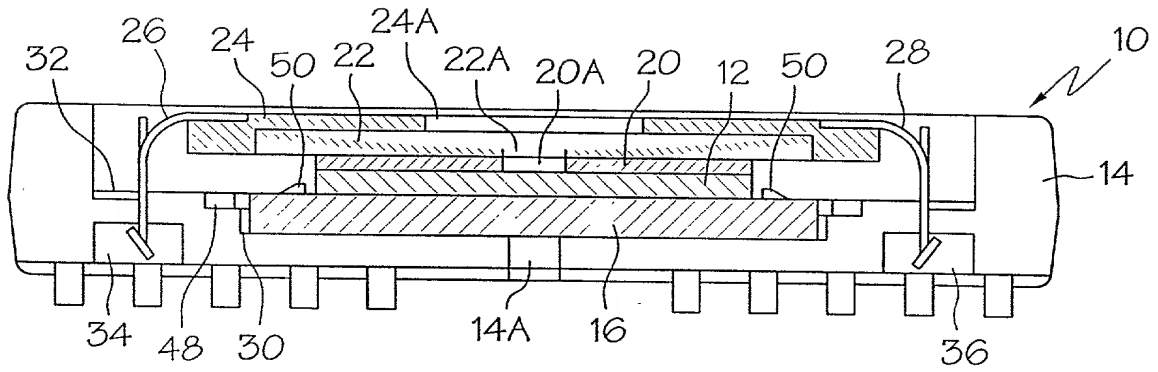


FIG. 2

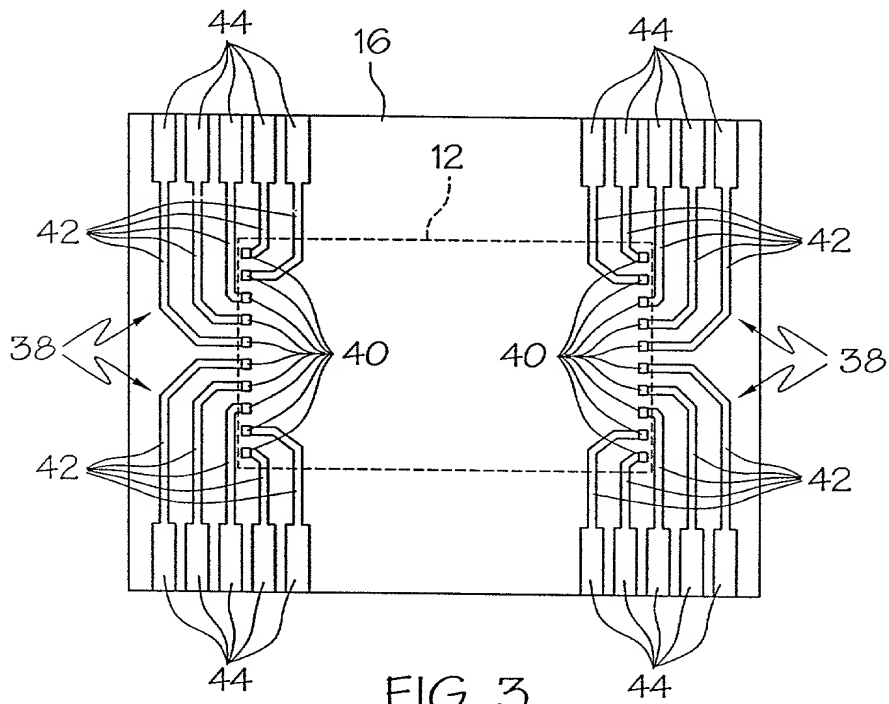


FIG. 3

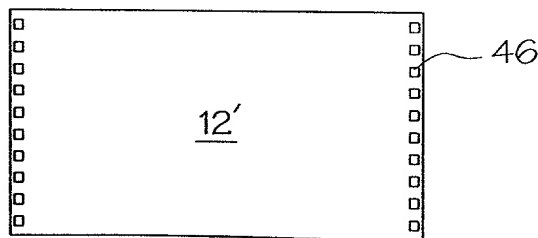
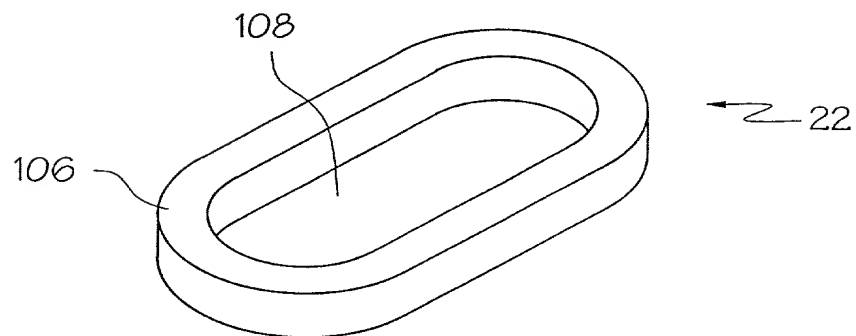
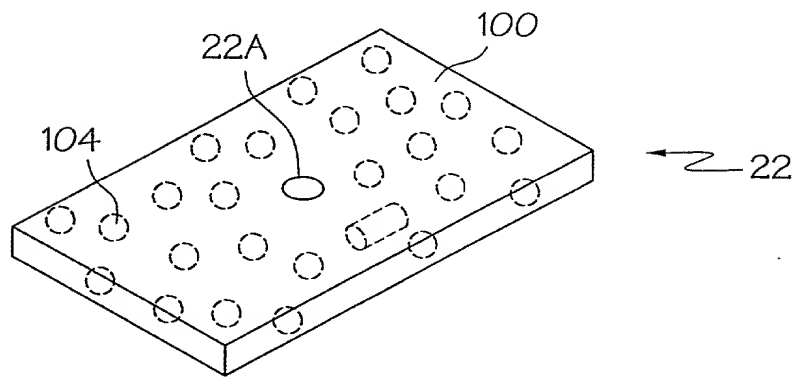
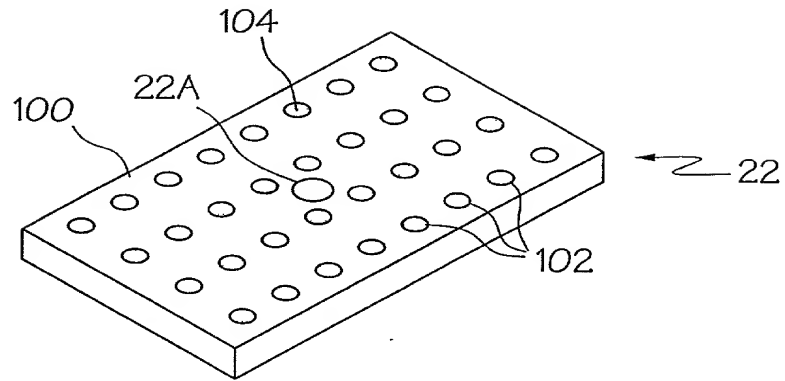
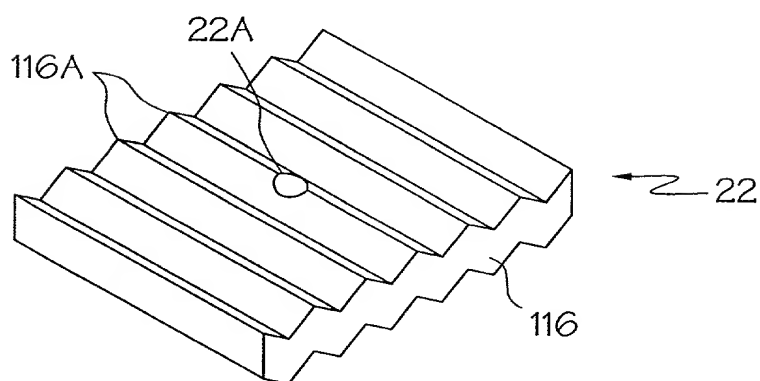
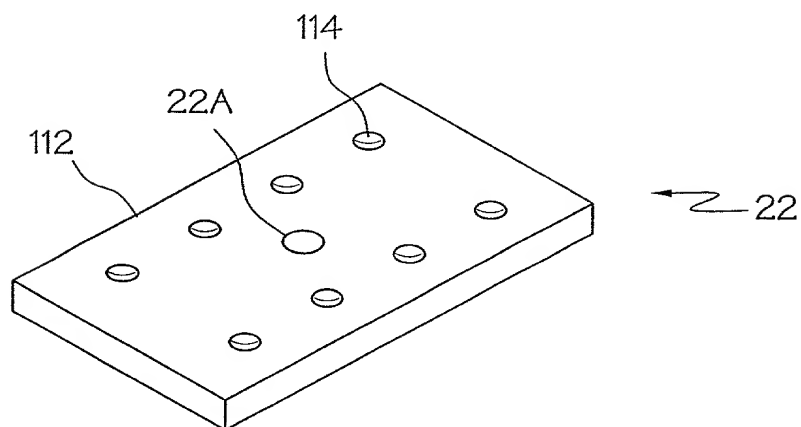
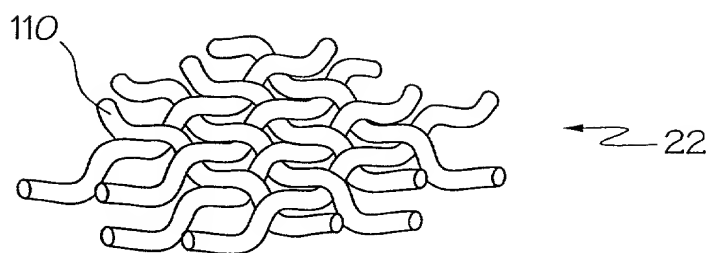


FIG. 4







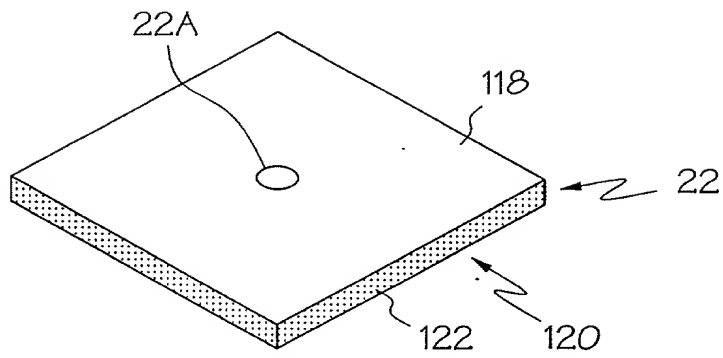


FIG. 13

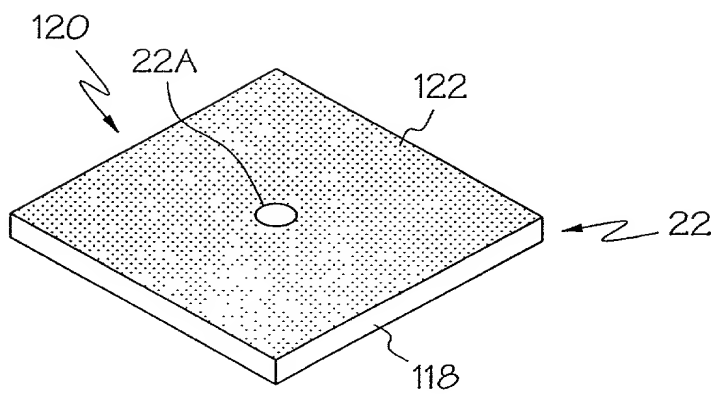


FIG. 14

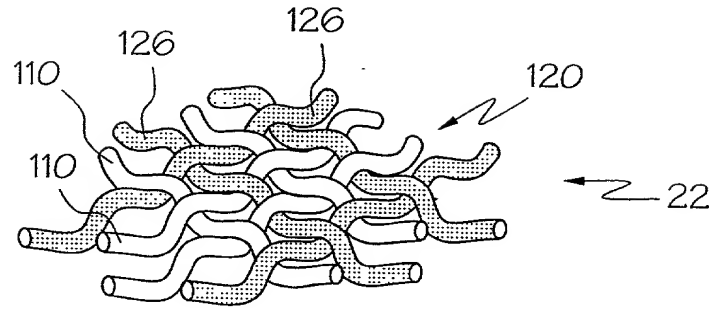


FIG. 18

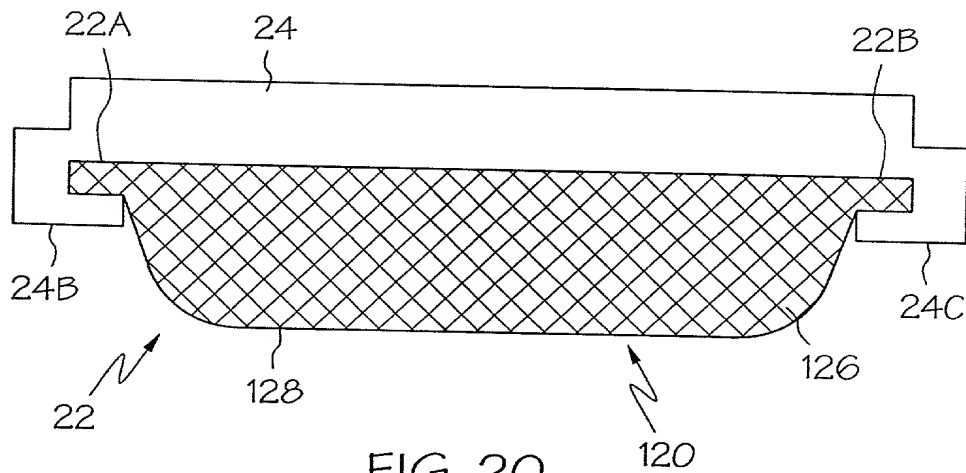


FIG. 20

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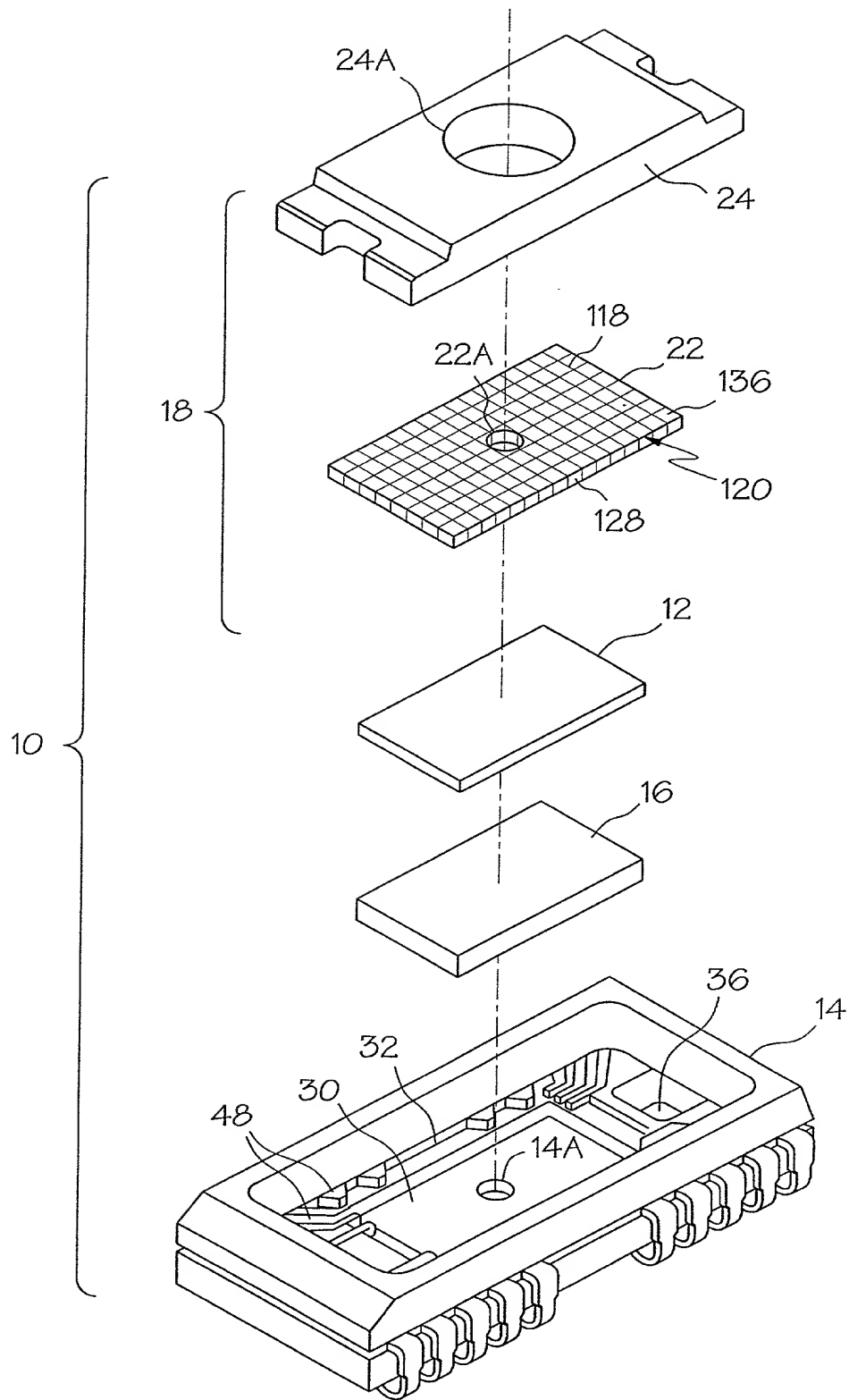


FIG. 19

DECLARATION AND POWER OF ATTORNEY
(Division, Continuation, or C-I-P)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; that

I verily believe I am the original, first and sole inventor (if only one name is listed below) or a joint inventor (if plural inventors are named below) of the invention entitled:

A SPRING ELEMENT FOR USE IN AN APPARATUS FOR ATTACHING TO A SEMICONDUCTOR AND A METHOD OF ATTACHING (Docket No. MIO 020 IA), described and claimed

 X in the attached specification;
 in the specification filed _____,
as U.S. Application Serial No. _____, and as
amended _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as filed and as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status
<u>09/009,169</u>	<u>January 20, 1998</u>	<u>Pending</u>

[illegible]

Paul H. Hahn

Schwer Akten

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8000 S. Federal Way
Boise, ID 83706-9632

POWER OF ATTORNEY

Applicants: David R. Hembree, Salman Akram, and Derek Gochnour

Application No.: _____ Filed: _____

Entitled: A SPRING ELEMENT FOR USE IN AN APPARATUS FOR ATTACHING
TO A SEMICONDUCTOR AND A METHOD FOR MAKING (Docket MIO 020 IA)

CERTIFICATE UNDER 37 CFR 3.73(b)

Micron Technology, Inc., a corporation of the State of Delaware, with a place of business at 8000 S. Federal Way, Boise, ID 83706-9632 certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of either:

A. ☒ An assignment from the inventor(s) of the patent application identified above, a copy of which is attached.

OR

B. ☐ A chain of title from the inventor(s), of the patent application identified above, to the current assignee as shown below:

1. From: _____ To: _____

The document was recorded in the Patent and Trademark Office at
Reel ____ Frame ____, or for which a copy thereof is attached.

2. From: _____ To: _____

The document was recorded in the Patent and Trademark Office at
Reel ____ Frame ____, or for which a copy thereof is attached.

3. From: _____ To: _____

The document was recorded in the Patent and Trademark Office at
Reel ____ Frame ____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

☐ Copies of assignments or other documents in the chain of title are attached.

The undersigned has reviewed all the documents in the chain of title of the patent application identified above and, to the best of undersigned's knowledge and belief, title is in the assignee identified above.

The undersigned (whose title is supplied below) is empowered to sign this certificate on behalf of the assignee.

Micron Technology, Inc. hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Richard A. Killworth	Reg. No. 26,397
James F. Gottman	Reg. No. 27,262
Timothy W. Hagan	Reg. No. 29,001
Richard C. Stevens	Reg. No. 28,046
Robert L. Showalter	Reg. No. 33,579
Susan M. Luna	Reg. No. 38,769
James E. Beyer	Reg. No. 39,564
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Micron Technology, Inc. hereby declares that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: Feb 18, 1992

Name: Michael L. Lynch

Title: Chief Patent Counsel

Signature: 

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